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Organic coating for mild steel structures and equipments used for sugar industries

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Epoxy and chlorinated rubber based paints were formulated for the use in sugar factory on mild steel structures and equipments. The coatings performance was evaluated by accelerated laboratory tests, immersion test and impedance measurements in 20% sugar solution with pH 5.5 and the results are presented in this paper.

Key words: Organic coatings, sugar industries, corrosion protection

INTRODUCTION

In sugar industries, the mild steel structures and equipments are affected by corrosion due to high temperature, acidity in sugar cane juices and impurities in the juice [1]. Organic coatings available from the industries were found to be not effective in preventing corrosion. Hence there is a need to develop coating formulation which will prevent the corrosion effectively.

EXPERIMENTAL

Paint preparation

The epoxy and chlorinated rubber based paints were prepared using the pigments and extenders such as TiO_2, talc, mica and bentonite. The physical properties of the liquid paints were tested as per ISI specification IOI.

Panel preparation

Three different sizes of mild steel panels (5 × 5 cm, 10 × 15 cm, 20 × 30 cm) were prepared and one set of the plates were pickled in dilute hydrochloric acid and another set of the plates were simply wire brushed and cleaned. These panels were painted to the thickness of 50 μm by brush and dried for 7 days and then used for all the tests.

Testing and evaluation

Physical properties: The physical properties of the coated mild steel panels such as thickness, scratch hardness, flexibility, impact resistance, adhesion and wet abrasion were measured.

Cyclic humidity cabinet: Triplicate coated panels were kept in the accelerated humidity chamber with 100% RH and the temperature maintained between 315–321K for one month period; after that the panels were examined for corrosion.

Immersion tests: Another set of the coated panels were immersed in 20% sugar solution (pH 5-5.5) at 298–303K, 333–338K, 373–378K for 100 hrs. and the gloss and adhesion of the coatings examined.

Electrochemical measurements: The A.C. impedance measurements were carried out with the specimen in the sugar solution with PAR model 368-1AC impedance system. The measurements were made at frequencies from 100 kHz to 0.1 Hz and the applied signal amplitude was 10 mV.

RESULTS AND DISCUSSION

The flexibility, impact resistance and wet abrasion test results showed that both systems were good, but the hardness and adhesion of epoxy based paint were slightly better than those of chlorinated rubber paint. The panels painted after pickling were not affected in the humidity cabinet test for one month while those painted without derusting started rusting. The immersion test results showed that the adhesion of epoxy paint was better than chlorinated rubber paint especially in higher temperature.

The impedance plot of the coating system obtained showed the general trend of mixed activation and diffusion control electrochemical process. The extrapolation of the first depressed semicircle gave the charge transfer resistance Rt and that of the second semicircle represented Rt′. The capacitance of the first interface represented Cp and that of the second interface was Cp′. The values of the Cp and Cp′ depend upon both the physical and chemical nature of the coating, particularly, its thickness and chemical composition [2].

The impedance plot of both the systems showed an initial high frequency semicircle attributed to the paint coating followed by a mid freqeuncy semicircle and a raising Warburg diffusion impedance 'tail'. The initial charge transfer resistance of chlorinated rubber paint was much higher (Rt = 4 $\times 10^3$, Rt′ = 10 $\times 10^2$ ohm cm^2) and the capacitance was lower (Cp = 374 $\times 10^{-2}$ m, Cp′ = 25 $\times$ 10^{-8} $\mu F\ cm^{-2}$) than that of uncoated plate in sugar solution (Rt = 55 ohms cm^2, Cp = 45 $\times$ 10^{-15} $\mu F\ cm^{-2}$). However these values were gradually changed in 30 days of immersion. Similarly the Rt values of epoxy paints initially and after 30 days were Rt = 4.27 $\times 10^7$, 5.8 $\times 10^3$ ohms cm^2 and that of Rt′ value after 30 days was 0.3 $\times 10^4$ ohms cm^2. The Cp values of the coatings were 662 $\times 10^{-12}$ and 21 $\times 10^{-9}$ $\mu F\ cm^{-2}$ and the Cp′ value after 30 days was 482 $\times 10^{-9}$ $\mu F\ cm^{-2}$.

The charge transfer resistance of epoxy paint was much higher than that of the chlorinated rubber paint and also it gradually decreased with time. This difference of behaviour with respect to time indicates the differences in dissolution of iron in the absence and presence of the paint coating [3]. The capacitances of the interfaces of both the systems were initially much low and subsequently increased with penetration of water inside the coatings. This represents that the organic coating introduced extra resistance path into the corrosion reaction at the beginning, which decreased in due course.

CONCLUSION

The resistance value of epoxy based coatings were much higher than that of the chlorinated rubber based paint for both low and moderate temperatures in sugar solution. Hence epoxy based paint is better than chlorinated rubber in equipments used in sugar industries.

REFERENCES

1. K K Menon, *Trans SAEST*, **14** (1979) 157
2. S Feliu et al, *10th ICMC*, **2** (1987) 1235
3. J A Van Frauvhofer and J Boxwell, *Protective Paint Coatings for Metals*, Port Culling Press Ltd., Surrey, England (1976) p 110